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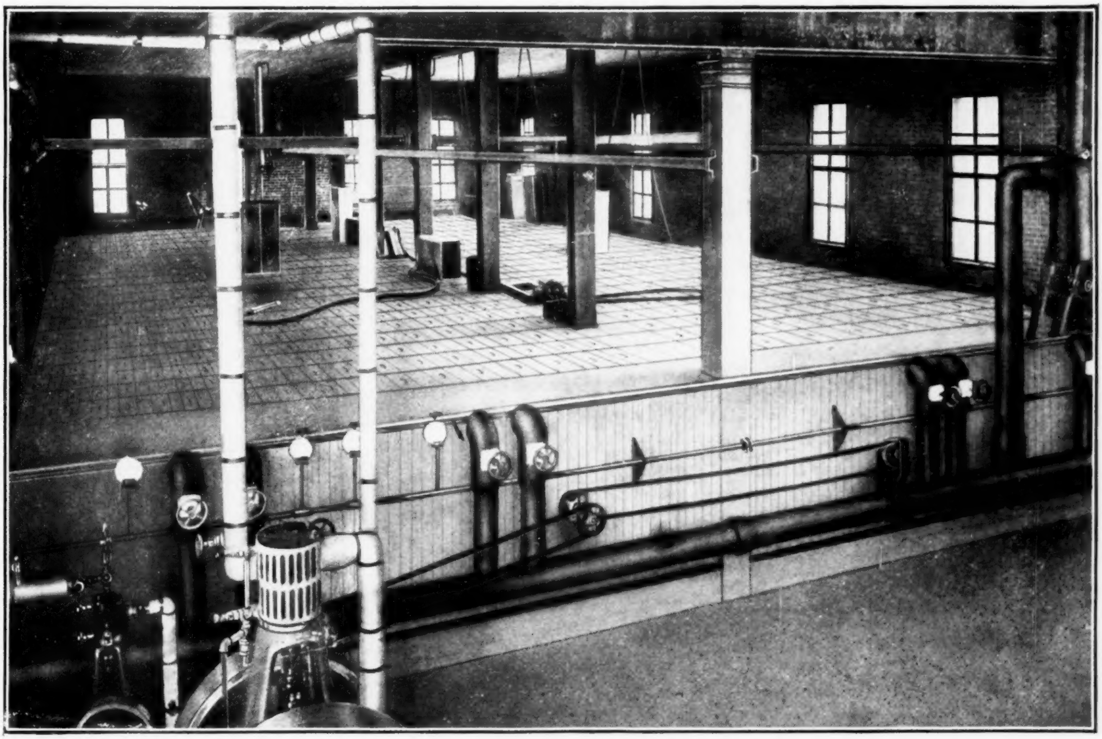


STEAM CYLINDER LUBRICATION in the Refrigerating Plant

IN the March issue of LUBRICATION we discussed "Refrigerating Machinery Lubrication" and pointed out how vitally the oil employed in the compressor cylinder affects the efficiency of the refrigerating plant. It is not the purpose of this article to deal at further length with the refrigerating side of the system. Instead we shall endeavor to point out how the lubrication of the steam cylinder in steam driven refrigerating plants influences the economy of those plants, and how many of the difficulties which constantly confront the operating engineer may be obviated and prevented.

Refrigerating plants may be readily divided into two classes, namely, those establishments which employ refrigeration for cold storage and cooling purposes, such as abattoirs, fur storages and hospitals, and those which are engaged in the manufacture of ice.

The problem of steam cylinder lubrication in the cold storage plant is no different from that met with in other lines of industry and will not be discussed further in this article. At some future date, however, we shall publish an article in LUBRICATION dealing with steam cylinder lubrication in its broadest sense.

In ice plants three different processes are employed, commonly known as:—

(a) The plate system
(b) The cell system
(c) The distilled water can system

The plate and cell systems are not used to any extent in this country. They require a larger plant for successful operation and cost considerably more to build than plants operating on the can system, but they have a great economical advantage over the latter in that they are capable of producing clear ice from raw water. No distillation is required in so far as the clarity of the ice is concerned, and even when economical considerations make necessary the use of exhaust steam for ice making, the nature of the processes is such that a slight trace of cylinder oil offers no difficulties.

On the other hand, clear and hygienic ice may be produced by the can method only when distilled water is provided. In order that ice may be clear and pure the water from which it is made must be free from colored animal, vegetable and mineral matter and also gaseous impurities. Some plants using the can system operate the ice making plant in conjunction with other processes and it is often found advantageous to use the exhaust steam for heating or other purposes. When this is done no oil from the cylinders gets into the ice cans and consequently, steam engine lubrication has no bearing upon the quality of the ice produced.

The great majority of ice plants are situated in large centers of population where the cost of both fuel and water is an important factor in the operation of the plant. In such cases economy is always promoted by using the engine exhaust for ice making purposes. This is the only case where steam cylinder lubrication problems arise which in any way differ from the problems of other steam driven plants.

Should the only consideration be lubrication, the oil problem in distilled water ice plants using exhaust steam would be the same as in other steam power plants, but the lubrication of steam cylinders in the former case presents a more complicated problem than the lubrication of steam cylinders where the exhaust steam is used for other than ice making purposes and the condensate is not required to be chemically and hygienically pure.

Cylinder oils used in plants employing exhaust steam for ice making purposes have two distinct functions to perform:—

I. They must lubricate the reciprocating parts of steam cylinders and valves.

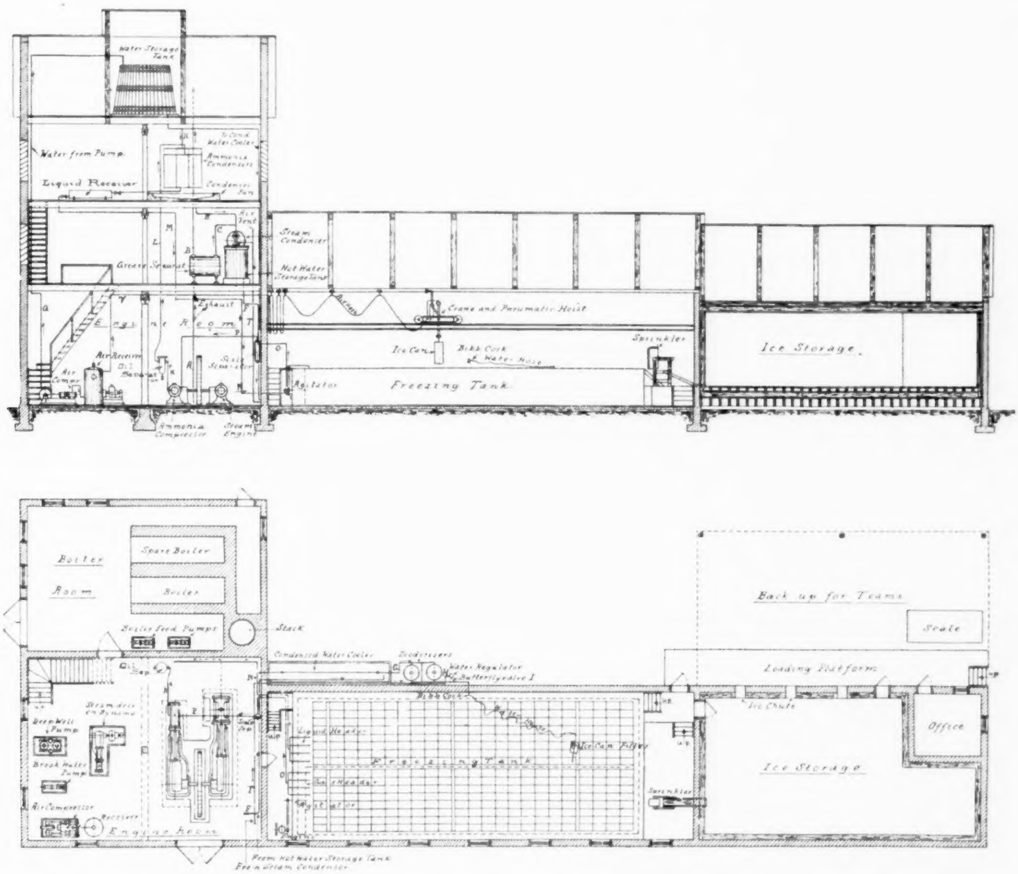
II. They must separate freely and completely from the condensed steam in the distilling apparatus.

Steam cylinder lubrication, no matter for what purpose the engine may be used, is one of the most difficult problems with which the lubricating engineer has to contend. A steam cylinder is alternately a boiler and a condenser and, as a result, a cylinder oil is required to withstand the vaporizing tendency of the hot cylinder wall and the very injurious washing action of boiler water either in the form of condensed steam or water resulting from priming and foaming. In addition, the sliding of the piston rings over the surface of the cylinder and the movement of the valves create a certain amount of friction, which, if not reduced by some lubricating medium, causes a considerable loss of power and at the same time, rapidly wears away the cylinder walls, piston rings and valves.

Steam engines used in ice making plants are usually of the small vertical and Corliss

types, although for the larger installations compound engines are very popular. Probably the most difficult type of steam engine to lubricate is the Corliss because of the difficulty of getting oil to the valves and more especially to the exhaust valves. Piston valves, and other forms of completely balanced valves, offer no difficulties in the way of lubrication as they receive a copious supply of oil and are not exposed to any great pressure. Unbalanced slide valves, on the other hand, are hard to lubricate, and sometimes control the nature of the lubricant to a greater extent than the cylinder itself.

Vertical cylinders and pistons having tail rod support are comparatively easy to lubricate, but because of the tendency of ordinary horizontal pistons to wear away the bottom of the cylinder, more lubrication is required than in the case of those just named. Engine speed also affects the type of oil fed to the cylinder, not only because of the increased piston travel per minute but also because of the velocity of the steam at the point of introduction. A steady load such as is met with in the ice plant is favorable to economic lubrication because the amount of oil fed to the cylinder can be reduced by degrees to a safe minimum without danger of a sudden change of speed damaging the cylinder.



PLAN AND ELEVATION OF A TYPICAL ICE PLANT CAN SYSTEM

In addition, the lubricating engineer must always take into consideration the general operating conditions, such as type of boiler, character of water used for boiler feeding, steam pressure and moisture content, its temperature at the throttle, the point of introducing the oil into the flow of the steam and the kind of lubricator used.

A great many plants use boiler compounds of one kind or another and these contain

soda ash or lime. After a period of time the concentrated condition of the water in the boiler becomes such that, even with frequent blowing, the boiler will prime and, in spite of well designed and located separators, some of the compound gets into the cylinders where it has a very bad effect upon the oil film covering the valves and cylinder wall. To successfully resist the action of boiler compounds cylinder oils should be so manufactured as to cling persistently to the valves and cylinder wall.

The pressure of the steam used in a plant or, in other words, its temperature, also has an important bearing upon the type of cylinder oil used. Under high temperatures oils have a tendency to vaporize, but fortunately, they also atomize readily and consequently it is possible to use a heavy oil. Where steam pressures are low it is necessary to use an oil which atomizes rapidly, that is, a light oil. Low steam temperature naturally permits rapid condensation and, as a result, there will be considerable water formed in the cylinder. Long steam lines and inefficient traps are also frequently the cause of water in the cylinder. An oil to resist the destructive washing action of this water must possess great natural adhesiveness or must contain some material which will supply the adhesive element.

Oil is fed into the cylinder in one of two ways. It is either supplied directly to the steam valves or is atomized in the steam pipe and carried in by the steam itself. The point of introduction has an important influence upon the operation of the plant. High steam pressure will produce quicker atomization than low pressure due to the fact that the high temperature thins down the oil to a greater extent, consequently, for a given oil complete atomization will take place in a shorter distance under high pressure, or vice versa, a heavy oil will be atomized as easily under high pressures as a comparatively light oil under low pressure. A light bodied or a filtered oil will atomize more quickly than a heavy bodied or an unfiltered oil. The farther the point of introduction is from the engine the more complete the atomization. There is a practical limit to this distance, however, for if the oil is introduced too far back it will condense upon the walls of the steam pipe and finally reach the cylinder in liquid form. A good average distance for the introduction of oil into the steam is 3 feet back of the throttle valve. When cylinder conditions require a heavy oil it will usually have to be introduced at a greater distance above the throttle valve than when a lighter oil is used.

Of the two types of lubricators, mechanical lubricators of good design have proven to be more reliable and positive in their action and more economical in the amount of lubricating oil used. The hydrostatic lubricator is not as easily regulated as the mechanical lubricator, is affected by the surrounding temperature, and in cold weather often will not handle satisfactorily the oil most suited for the cylinder.

It was pointed out above that where boiler compound or water reach the cylinder it is necessary to use an oil possessing pronounced adhesive properties in order to secure the best lubrication. Mineral cylinder oils do not possess, in themselves, sufficient adhesiveness to enable them to cling to the cylinder wall for any length of time when subjected to excessive moisture in the steam, so for this purpose certain fatty oils are added to mineral cylinder oils, and when these come into contact with the moisture in the steam they readily emulsify and cling tenaciously to the cylinder wall. The amount of animal fat used in cylinder oil varies from 3 to 12 per cent., depending upon the amount of moisture to be taken care of.

In spite of the many advantages they possess, oils containing animal fats, or compounded oils as they are called, are objectionable in the distilled water plant because of the difficulty of removing the fatty matter from the exhaust steam and the consequent effect which this matter has upon the ice. Compounded oils, if carried over with the exhaust steam, almost invariably discolor the ice and render it more or less unfit for edible purposes.

It is advisable to use compounded oils in

the ice plant only when it has been found absolutely impossible to lubricate the cylinders and valves with a straight mineral oil, and then only in the smallest quantities. Even mineral cylinder oils should be used with the greatest caution. Although mineral cylinder oils do not resist water conditions like compounded oils, they are to be preferred in the ice plant even though larger quantities must be fed into the cylinder in order to provide efficient lubrication. Operating engineers in distilled water plants should always use mineral cylinder oils if it is at all possible.

In order to appreciate the bearing which oil separation has upon the operation of the distilled water or can ice plant it would seem necessary at this point to dwell briefly upon the layout and operation of one of these.

The can system consists of a large shallow tank containing refrigerating coils immersed in a brine. These coils are so arranged that rows of deep cans filled with water may be set between them and anchored or "buttoned" there. The evaporating ammonia in the coils cools the brine which in turn abstracts heat from the water in the cans and eventually freezes it. After the ice has been formed the can is lifted from the brine tank and placed in a dumper which automatically heats the can and allows the cake to slide out and down an incline to the storage room. The can is then again inserted in the brine and refilled with water.

As all the water intended for freezing in the can system has to be distilled, it is customary, for the sake of economy, to redistill the condensed engine exhaust along with any additional water which may be required in order to eliminate all traces of oil and other impurities.

The exhaust steam from the engine, bearing a certain amount of oil emulsion, first enters the oil separator where it gives up whatever water it contains and also the oil emulsion not in solution .The separation of oil from exhaust steam is a simple matter if a suitable separator is provided of sufficient size to allow ample time for separation. The oil separator should be given careful attention at all times to see that it is kept clean and in efficient working condition. When this is done no trouble will be experienced in oil removal. The oil separator is usually placed close to the condenser in order that the exhausted gases may become as cool as possible.

Too much importance cannot be attached to the oil separator in the distilled water ice plant, not only because complete separation is essential to clear ice, but also because of the economy obtained by using the oil over again. Oil separators frequently influence the selection of the cylinder oil and upon their efficiency depends much of the success of the plant. Many engineers are inclined to underestimate the importance of oil separators.

From the oil separator the exhaust steam passes to the condenser where it is liquefied and then carried to the reboiler. The reboiler is depended upon to remove all air and other gases from the condensate and also to eliminate the oil which passes the oil separator. Reboilers usually are equipped with skimming devices which remove the impurities from the reboiler as fast as they accumulate upon the surface.

From the reboiler the water flows to a hot water filter containing crushed quartz, and then to the distilled water cooler.

Leaving the cooler the water passes to a forecooler which reduces the temperature to 45 or 50 degrees F. and then feeds it to another filter or deodorizer containing charcoal or fine sand. If it is found necessary the cold water may be stored in a tank before being delivered to the ice cans. If not, it may be delivered to the cans directly from the filter.

The illustration on the next page shows a typical layout for a distilled water plant which is driven by a compound engine. Compound engines are used to drive the ammonia compressors in many of the larger plants but they do not exhaust enough steam to supply the ice cans with water, and as a consequence, an extra piece of apparatus has to be inserted in the distilling system called an evaporator. The evaporator makes use of the heat in the exhaust to distill whatever additional water

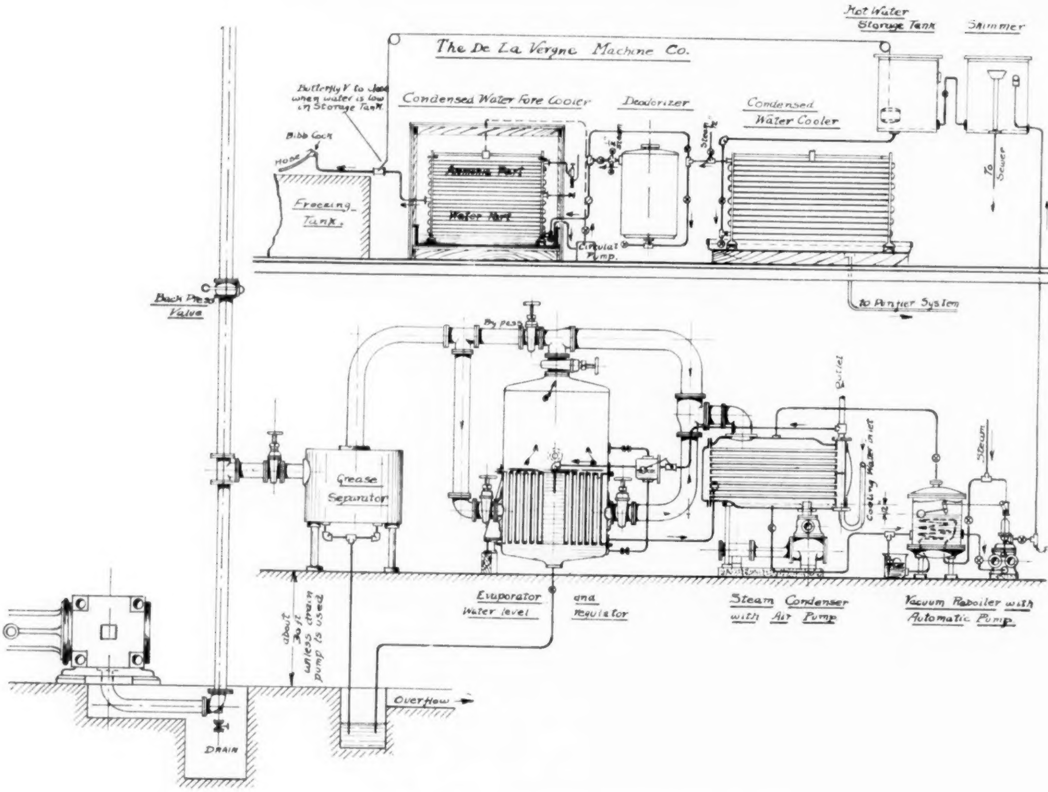


DIAGRAM OF DE LA VERGNE DISTILLING PLANT

is needed to supplement that obtained from the engine exhaust, making it unnecessary to draw steam from the boiler. Outside of the evaporator this layout is typical of those used in plants where the engine supplies sufficient steam for ice making purposes.

In the manufacture of ice by the can method, operating engineers are confronted with a number of difficulties which, however, we shall group under four heads:—

(a) Porous ice
(b) Opaque or white ice
(c) Discolored ice
(d) Hygienically impure ice

Porous ice is due entirely to too rapid freezing and is usually most pronounced upon the outside of the cake. The reason for this is that the ice crystals do not have a chance to consolidate properly. This condition can always be remedied by raising the temperature of the brine.

Opaque ice may be restricted to the top or center of the cake or the entire mass may be in this condition. Occasionally opaque ice is due to too rapid freezing, but for the most part it is due to minute bubbles of air which form snow during the freezing, process. In the plate method freezing proceeds from one side only and the air and impurities are not included in the ice. In the can method, however, freezing proceeds from all sides and the bottom and as a consequence the air is finally imprisoned in the center of the cake where it makes a white core. It is for the purpose of removing this air that water intended for the ice cans is distilled. Efforts have been made to remove air from raw water in cans by agitation and other means but these have met with only partial success. Raw water ice manufacture is as yet only in its infancy, but the time is undoubtedly not far distant when methods will be perfected by which air may be eliminated from water by other means than boiling.

Discolored ice probably causes more complaints than any other factor in the ice

business. Discoloration may be attributed to a number of sources, but if the cylinder oil is getting into the ice cans its presence is always evidenced by a yellowish fan, or "V" shaped accumulation near the top of the cake. Rust formed somewhere in the system may also stain the ice but discoloration from this cause may appear anywhere in the ice and is without distinctive formation. Red ice is due to rust or the presence of carbonic acid. Specks may usually be attributed to scale from the reboiler, but filters, if functioning properly, should remove all scale and rust. A filter placed between the forecooler and the ice cans is especially useful in preventing red in the ice, because of the fact that the red matter does not precipitate until a temperature approaching freezing has been reached. All water connections should be of galvanized iron or copper alloys and the whole system should be kept clean.

It is a regrettable fact that the moment discoloration appears in the ice many operating engineers at once attribute the trouble to unsuitable cylinder oil, when, as a matter of fact, the oil is in no way to blame. In one instance an ice manufacturer was troubled with a heavy core and butt in his ice and in an effort to prevent it he tried all kinds of cylinder oils without result. Eventually it was discovered that the trouble was due to boiler priming. When ice begins to discolor, even though the evidence points to the presence of oil, no change should be made in the lubricant used until all the equipment has been examined and the trouble definitely fixed. In our experience we have found that discolored ice is more often due to lack of attention to filters than to any other cause.

Discolored ice not only arouses the suspicions of the consumer but sometimes it is actually unfit for human consumption. Ice is an edible product and its purity should be carefully guarded throughout the entire plant, especially in the condensing equipment. A thin coating of clean, straight mineral cylinder oil in this part of the plant is not objectionable, as it is a protection to the metal surfaces and prevents rusting during the period of time that the plant is not in operation. However, it should not be forgotten that a film of oil, no matter how thin, is an effective barrier to the transfer of heat and should not be allowed to become too thick.

In many plants the water is chemically and hygienically pure until it reaches the cans, but because of carelessness at this point, the water is contaminated and all the efforts made in the interests of purity undone. It is not an uncommon sight to see employees go to the tank deck directly from the street, and visitors are also allowed to walk on the can covers with dirty shoes. The covers of the cans are always more or less wet and it is an easy matter for the unclean water formed to get into the cans. The inevitable result is discolored and impure ice. At times the cans are allowed to become rusty and gum up in the corners. This matter eventually finds its way into the ice as well.

The selection of a cylinder oil is largely a matter of judgement, experience and a knowledge of the physical conditions in any given plant. On the whole, however, the lubrication of steam cylinders in ice plants requires more careful analysis than the lubrication of steam cylinders in other types of steam power plants, where the condensate is not required to be perfectly free from oil and other impurities. It has been pointed out that lubrication and separation must both be considered in deciding upon the suitability of a cylinder oil for ice plant lubrication, and of these, undoubtedly the most important is separation.

In addition to the requirements already pointed out, uniformity is a factor which should be given careful consideration by the operating engineer, not only because of the economy which can be secured through the use of an oil which is always the same, but also because of the sense of security which results. If the plant operator is confident that the oil he is using is uniform and of good quality and some trouble arises in the plant, he will immediately pass up the question of lubricating oil and proceed to find the trouble elsewhere, with the result that he will locate the trouble and remedy it without

making a complaint on the oil which is not justified.

One thing which will greatly facilitate the selection of the proper cylinder oil is complete co-operation between the operating and lubricating engineers. Perfect frankness and truthfulness on their part always will lead to a more intelligent selection and higher lubricating efficiency. Operating engineers know the peculiarities of their plants, but they should not forget that any suggestions made by lubricating engineers are worthy of their consideration. These men have devoted a great deal of time and study to the business and by experience have gained knowledge which is valuable. Their mission, in a word, is to furnish better lubrication at less cost.

There is very little doubt that the question of lubrication in distilled water ice plants is receiving more careful attention than it has in the past. There are many reasons for this, one of which is the increasing demand for, and the cost of, lubricating oils. Cylinder oils as marketed today are the result of years of experiment, and little improvement can be hoped for in the oils themselves. The field which promises the maximum results regarding efficient lubrication lies in better and more scientific methods of application, the selection of the proper grade of oil for the purpose and the reclamation of used oils so far as this is possible. While the cost of lubrication may appear small in proportion to the total production cost per ton of ice when looked at from the viewpoint of sales, poor lubrication and inattention to the proper use of oil will assume an importance out of all proportion to the cost of a suitable oil and attention paid to its application.

FARM TRACTOR LUBRICATION

This article is intended to present to those familiar with automobile operation, a picture of the nature and duty of farm tractors in order that they may gain some idea of the differences in the lubricating requirements existing between the two. The same fundamental principles hold in both cases, so that the experience of an automobile man is applicable to this field as soon as he becomes familiar with the many different types of tractor construction and the varied conditions under which they operate.

The same development of mechanical labor saving devices which has characterized and made possible our industrial growth during the last decade is now well under way with respect to agriculture. Animal power has been used upon the farm from the earliest times and it is only natural that such a faithful source of energy would be hard to displace by an expensive mechanical device. The trouble is that the farmers do not realize how much animal power really costs them. In one year a horse will consume the produce from five acres of land, whether he works or not. In addition the first cost, including harness, is high. This matter of cost was the first incentive to the development of farm tractors. There is still some question as to whether it is profitable to use tractors on farms of less than 100 to 150 acres, but even after deducting these there remain over 2,000,000 farms in the United States large enough to support tractors. In 1919 there were about 200,000 tractors in use which indicates the possible growth of this industry.

The conditions under which farm tractors are operated are much different from those of a truck or a pleasure car. During the summer months the tractor operates in the intense heat of the sun and in the winter at

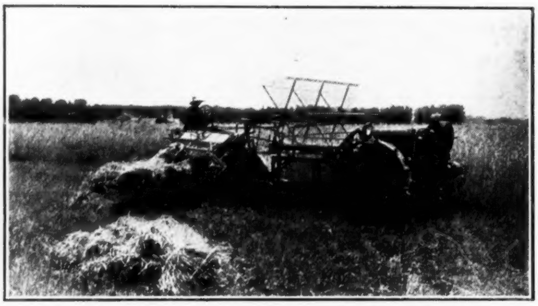
THE ADAPTABILITY OF TRACTORS TO ALL CLASSES OF WORK IS ONE OF THEIR GREATEST ASSETS. A LARGE TRACTOR BELTED TO A PUMP.

temperatures frequently well below zero. To successfully replace the horse, tractors must be ready for instant use at any time. Economic necessity demands that any mechanical device shall be allowed to stand idle as little as possible, and for this reason tractors are called upon to do all manner of work. When they are not plowing, disking, or harrowing, they are belted to threshing machines, huskers, buzz-saws, and any device for which power is desired. Furthermore, no other type of self-propelled vehicle has to work under such extreme conditions of mud and dust as the farm tractor, and these conditions are often aggravated by the lack of care given the machines.

Farm tractors are not yet standardized to a characteristic type. When thinking of an automobile a definite type comes to mind, but in the tractor field may be found every imaginable type of construction, although the tendency is toward standardization. For example, almost all recent designs make use of four cylinder engines, but among the old established types many of one and two cylinders may be found. The accompanying illustrations show the great diversity of type and size.

One great difference between farm tractors and automobiles is that the engine of the tractor is subjected to much heavier duty. A heavy touring car may be equipped with an engine capable of developing 70 or 80 H.P. and yet under normal conditions but 10 or 12 H.P. will be used to drive it at 30 miles an hour on good roads, and the average power delivered may be less than this. The maximum power is only occasionally developed, otherwise a much shorter life would result. A tractor engine, however, is subjected to small fluctuation of load, and if rated at 10 H.P. should be able to develop 10 H.P. all day long without trouble or unreasonable wear. To insure against any excess speed, governors are generally employed and these limit the power developed by holding the piston speed down to 700 to 900 feet per minute.

In addition to the heavy duty required of tractor engines they are subject to comparatively rapid wear when dust collects in the lubricating system. Those who have seen tractors at work are familiar with the dense clouds of dust which sometimes surround the machines. Some of this dust enters the carburetor with the air and may then get into the crank case by working past the piston rings. If the breather is not well protected dust may also enter the crank case directly and contaminate the lubricating oil. Dust contains abrasive material and irrespective of the source of its presence in the engine it causes undue wear. A case is known where the piston rings wore so thin after two days' service where no precautions were taken to keep dust out of the engine, that they actually broke in pieces. The only safeguard is to keep dust out of the engine. This is accomplished, to a greater or less degree, on most tractors by the use of air cleaners. These cleaners are sometimes ordinary centrifugal separators such as are used to separate saw dust and air in mills, but more frequently air is drawn through water and the dust washed out. A very simple arrangement draws the carburetor air through a "stack" which projects six or seven feet above the ground where there is less dust, and frequently, a stack is used in addition to a cleaner. Dust which does get past air cleaners makes it necessary to drain out all oil from the crank case frequently, though after proper filtering it may be used again.



AN EXAMPLE OF THE TWO-WHEELED TYPE. DRAWING A TEN FOOT GRAIN BINDER.

Tractors consume such a large quantity of fuel because of their heavy continuous duty that economy is usually sought by using kerosene instead of gasoline. When this is done a gasoline connection is usually made to the carburetor to facilitate starting.

There are very few tractors which vaporize kerosene perfectly, and the result is that kerosene works into the crank case and reduces the viscosity of the lubricating oil to such an extent as to make it advisable to discard it entirely after only a few days use. There are many instances where kerosene enters the crank case faster than the oil is consumed, and overflows are provided to prevent the accumulation of too much of the mixture.

On some tractors the difficulties of oil dilution and contamination from dust are obviated by eliminating the circulating oil system and employing a force feed lubricator which supplies new oil from separate plunger pumps and oil lines to each bearing and cylinder. The oil flow starts and stops with the engine and the quantity of oil varies directly with the engine speed. The supply of oil fed to the various bearings may be adjusted to any desired quantity by regulating valves connected with each feed line. The lubricator is provided with a crank for pumping the oil by hand to the bearings when the engine is not running, and the operator should always turn the crank a number of revolutions before starting the engine. In this way oil is pumped by each plunger of the lubricator and gives the bearings oil for immediate use. This is very important and should not be overlooked. The fact that there is oil in a mechanical lubricator is not enough to insure lubrication of the bearings. The glass indicator on the lubricator should be ininspected often to see that each plunger is doing its work and no chance should be taken if the oiler does not seem to be working properly. The end of the oil pipe at the bearing should be removed and the crank turned to see that there is no restriction to the flow of oil.

The advantage claimed for the mechanical force feed lubricator is that a regular predetermined supply of fresh clean oil, uncontaminated with fuel, is fed to all cylinders and principal bearings, and the delivery of oil to the bearing surfaces is constantly in plain view through glass indicators. Of course, the oil from the bearings and cylinders is not used again for their lubrication and, unless use can be found for it on rough machinery or bull gears, it is thrown away. But even so, it is no more extravagant than throwing away all the oil from a circulating system every few days.

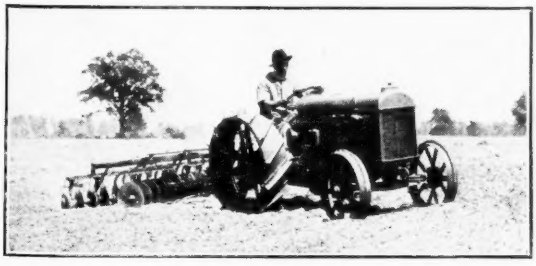
One of the very important functions of oiling systems on heavy duty engines is to carry away the heat of friction as well as to lubricate. A lubricator is deficient in this respect and limits the allowable bearing loads and speeds. Nevertheless lubricators are used on about one third of all tractors burning kerosene. Tractors which use circulating oil systems resort to the customary splash or full pressure systems of automobile practice, with a tendency toward the adoption of full pressure. Where circulating oil systems are used, too much care cannot be taken to assure

THE PERFORMANCE OF TANKS IN THE WAR HAS MADE THE TRACK-LAYER TYPE WELL KNOWN. NOTICE THE MUD CAKED UPON THE TRACK PARTS,—A FEATURE WHICH MAKES THE LUBRICATION OF THESE PARTS DIFFICULT.

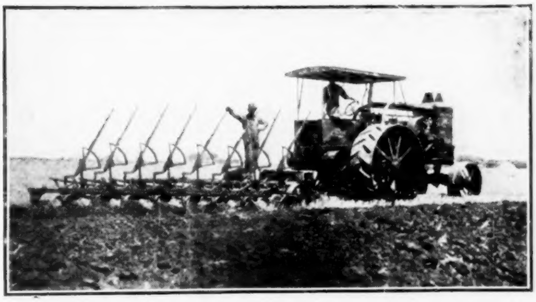
cleanliness, not only while the tractor is in operation, but when draining and refilling the crank case as well.

Even though the principles and design of tractor and automobile engines are practically the same, the lubricating oils used should be quite different in nature, because the duty required of the tractor is so much greater. Excessive engine speed is of course prevented by the governor, but the load is usually the maximum possible, and this continually subjects the lubricating oil to temperatures much higher than those which exist in automobile engines for only short intervals of time. The consumption of lubricating oil increases rapidly with temperature. Consequently an oil which would be perfectly satisfactory in an automobile engine might be consumed at an excessive rate in a tractor and would be so thin at the higher temperatures that abnormal wear might result. On the other hand, the use of viscous or "thick" tractor oils in an automobile would not only be of no benefit but would slightly reduce the power available, particularly at high speeds.

With all other factors equal, an engine using kerosene as fuel requires a more viscous oil if a circulating lubricating system is used, because the greater quantity of fuel which gets into the oil quickly thins it down. On the other hand, a less viscous oil may be used if a mechanical lubricator is employed since it is not subjected to even the milder dilution resulting from gasoline as a fuel. In extremely cold climates it is sometimes necessary to use an oil of low pour test. It is then clearly apparent that the class of service to which an engine is subjected has a marked bearing on the type of oil to be used, and it is



A CHARACTERISTIC FOUR-WHEELED TYPE OF MEDIUM SIZE, FOLLOWING AUTOMOBILE LINES. THIS TRACTOR IS CAPABLE OF PULLING TWO PLOWS



ONE OF THE LARGE TRACTORS WHICH CAN PULL EIGHT PLOWS OR FIVE BINDERS EASILY

for this reason that The Texas Company has brought out a series of Tractor Oils which are distinct from Texaco Motor Oils.

A few of the oldest tractor manufacturers use oil for a cooling medium in the jackets instead of water. This is an aid in securing engine temperatures sufficiently high to get better vaporization of the kerosene fuel. Another advantage of oil as a cooling medium is the elimination of the danger of freezing which is always possible with water, and in addition the increased viscosity at low temperatures automatically reduces the rate of circulation and cooling until the engine warms up, acting in the same way as the thermostat now being provided for many automobile cooling systems.

Tractor transmissions are very similar to those of automobiles, most of them having sliding spur change gears which give reverse and two, or sometimes three, speeds forward. The principal difference is that the total reduction between engine and drive wheels is so great, 40 or 50 to 1, that the transmissions usually consist of two distinct reductions in series, the last step being taken to a jack shaft which carries the differential. All these parts, as well as the drive to the shaft for the belt pulley, are usually enclosed in one housing and run in a bath of lubricant. There is no "direct drive" and the power is always transmitted through gears when the tractor is in motion. As a result the gears are subjected to severe service and their lubrication must be given careful attention.

In many tractors the gear housings are so large that the quantity of lubricant required to fill them often amounts to eleven or twelve

gallons and in some cases even to twenty gallons. When a heavy bodied gear lubricant is employed for this purpose it must be emphasized that only enough should be used to assure the lowest gears of each train dipping into the lubricant, because unnecessary power will be consumed in dragging the gears through it, especially in cold weather.

Before applying gear lubricants a careful investigation of the type of bearings always should be made. Some tight fitting plain bearings demand the use of a light lubricant. A mixture of gear lubricant with light motor oil or engine oil will usually prove satisfactory in such cases and it also may be used in very cold weather. In all cases, the transmission must be thoroughly cleaned before the fresh lubricant is installed and preferably washed with kerosene, but all kerosene should be removed from the housing.

Attention must again be directed to the importance of preventing any dust getting into the transmission case, and especially if a worm gear is used. Manufacturers object to worm drives for tractors principally because of the difficulty they have experienced in securing the proper lubricant and keeping it free from the dust which seems sure to find its way into the housing, ruining the worm and wheel in a very short time.

In the final drive of a tractor, use is almost always made of either the chain or gear type of drive and these are usually exposed, although sometimes use is made of a housing to keep out some of the dirt. These housings will hold grease but not oil. In a few designs the exhaust from the engine is directed against the exposed "bull gears" for the purpose of keeping the teeth free from dirt. Such exposed drives are used without any hope of securing sufficient lubrication to prevent rapid wear, and at best even the most efficient grease or oil can be considered as only a makeshift.

From the foregoing it may be seen that while the general mechanical principles involved in farm tractor construction are in no way essentially different from those of automobiles and motor trucks, yet the nature of service and the conditions of operation encountered, together with the care given, demand the use of a different class of lubricants from those which may be used satisfactorily on automobiles.

Many tractor operators have gained the impression that because their machines are employed upon rough work, most any kind of lubrication will do. Tractors are, however, just as well made as trucks or passenger cars and will give efficient service only with efficient lubrication. Not only does correct lubrication mean improved operation and increased production, but it also reduces wear and minimizes the probability of a breakdown. This last is of paramount importance for the reason that many tractors are located in districts considerably removed from repair stations and the failure of the tractor at a busy period will surely result in financial loss to the farmer.

TWO-WHEELED. THE SMALL SIZE OF THESE MINIATURE TRACTORS SEEMS TO BE NO HANDICAP TO THEIR ABILITY TO DO HARD WORK THEIR SIZE MAKES THEIR CONTROL RELATIVELY EASY